

CLAIMS

1. A method of forming a gate electrode comprising:

forming a gate structure on a semiconductor substrate, the gate structure having a gate oxide film pattern, a polysilicon film pattern, and a metal silicide film pattern; and

forming a first oxide film on a sidewall of the gate structure and on the semiconductor substrate by re-oxidizing the gate structure and the substrate under an atmosphere including an oxygen gas and an inert gas, wherein a portion of the first oxide film formed on a sidewall of the polysilicon film pattern has a thickness substantially identical to that of a portion of the first oxide film formed on a sidewall of the metal silicide film pattern.

2. The method of claim 1, wherein the polysilicon film pattern is doped with impurities chosen from the group consisting of Group III elements and Group V elements.

3. The method of claim 1, wherein a volume ratio between the oxygen gas and the inert gas ranges between about 1.0:0.9 and about 1.0:1.1.

4. The method of claim 1, wherein the inert gas comprises a gas chosen from the group consisting of nitrogen, argon, and helium.

5. The method of claim 1, further comprising, prior to forming the first oxide film:
setting a furnace temperature of a furnace in a range of about 400 to about 480°C;
loading the gate structure and the semiconductor substrate into the furnace; and
raising the furnace temperature to a range of about 800 to about 900°C while the inert gas is provided into the furnace.

6. The method of claim 5, wherein a flow rate of the inert gas is about 30 to 50 slm.

7. The method of claim 1, further comprising, after forming the first oxide film:
forming a second oxide film on the first oxide film by oxidizing the gate structure and the substrate in an atmosphere, wherein the atmosphere comprises a gas selected from the group consisting of an oxygen gas and a mixture of oxygen gas and a chlorine-containing gas.

8. The method of claim 7, wherein the chlorine-containing gas comprises one selected from the group consisting of HCl, Cl₂, and C₂HCl₃.

9. The method of claim 1, wherein the metal silicide film pattern comprises a tungsten silicide film pattern.

10. A method of manufacturing a semiconductor device including a gate electrode comprising:

forming gate structures on a semiconductor substrate, the gate structures having gate oxide film patterns, polysilicon film patterns, metal silicide film patterns, and nitride film patterns;

forming a first oxide film on sidewalls of the gate structures and on the semiconductor substrate by re-oxidizing the gate structures and the substrate under an atmosphere including an oxygen gas and an inert gas, wherein portions of the first oxide film formed on sidewalls of the polysilicon film patterns have a thickness substantially identical to that of portions of the first oxide film formed on sidewalls of the metal silicide film patterns;

forming nitride spacers on the sidewalls of the gate structures and the first oxide film;

forming an interlayer dielectric film to cover the gate structures;

forming a self-aligned contact hole exposing a portion of the substrate between the gate structures by partially etching the interlayer dielectric film; and

forming a contact by filling the self-aligned contact hole with a conductive material.

11. The method of claim 10, wherein the polysilicon film patterns are doped with impurities chosen from the group consisting of Group III elements and Group V elements.

12. The method of claim 10, wherein a volume ratio between the oxygen gas and the inert gas ranges between about 1.0:0.9 and about 1.0:1.1.

13. The method of claim 10, further comprising, prior to forming the first oxide film:

adjusting a temperature of a furnace for re-oxidizing the gate structures and the substrate so that the furnace has a temperature in the range of about 400 to about 480°C;

loading the substrate including the gate structures formed thereon into the furnace; and

raising the temperature of the furnace so that the furnace has a temperature in the range of about 800 to about 900°C while the inert gas is provided into the furnace.

14. The method of claim 10, further comprising, after forming the first oxide film:
5 forming a second oxide film on the first oxide film by oxidizing the gate structures and the substrate in an atmosphere chosen from the group consisting of an oxygen atmosphere and an atmosphere that includes an oxygen gas and a chlorine-containing gas.

15. A method for oxidizing a substrate comprising:
10 providing a furnace having a first temperature;
loading the substrate including a gate structure formed thereon into the furnace;
raising a temperature of the furnace so that the furnace has a second temperature higher than the first temperature while a first inert gas is introduced into the furnace; and
forming a first oxide film on a sidewall of the gate structure and on the semiconductor
15 substrate by re-oxidizing the gate structure and the substrate under an atmosphere including an oxygen gas and a second inert gas, wherein the first oxide film has a substantially same thickness on an entire sidewall of the gate structure.

16. The method of claim 15, wherein the first temperature is about 400 to 480 °C.

17. The method of claim 15, wherein the second temperature is about 800 to 900 °C.

18. The method of claim 15, wherein a volume ratio between the oxygen gas and
25 the second inert gas is about 1.0:0.9 to about 1.0:1.1.

19. The method of claim 15, further comprising, after forming the first oxide film:
forming a second oxide film on the first oxide film by oxidizing the gate structure and
the substrate under an atmosphere chosen from the group consisting of an oxygen atmosphere
30 and an atmosphere including an oxygen gas and a chlorine-containing gas.

20. The method of claim 15, wherein the gate structure has a gate oxide film pattern, a polysilicon film pattern, and a metal silicide film pattern that are sequentially stacked.